# Strategy Backtester

May 1, 2018

```
In [1]: %pylab inline
```

```
Populating the interactive namespace from numpy and matplotlib
```

## 1 Strategy Backtester

### 1.1 Data

From poloniex:
https://poloniex.com/public?command=returnChartData&currencyPair=USDT_BTC&start=1521746902&en

```
In [2]: import calendar
        import requests
        import pandas as pd
        from datetime import datetime, timedelta
```

```
In [3]: def unix_epoch_to_timestamp(epoch):
            return datetime.fromtimestamp(epoch).strftime('%Y-%m-%d %H:%M:%S')
```

```
In [4]: def timestamp_to_unix_epoch(ts):
            return calendar.timegm(ts.timetuple())
```

```
In [5]: class PoloniexDataFrame():
            def __init__(self, pair, timeframe, start, end):
                start = timestamp_to_unix_epoch(start)
                end = timestamp_to_unix_epoch(end)
                url = 'https://poloniex.com/public?command=returnChartData&currencyPair={}&sta
                print(url)
                json = requests.get(url)
                data = json.json()
                date, o, h, l, c = zip(*[(unix_epoch_to_timestamp(x['date']), x['close'], x['hi
                d = {'date': date, 'open': o, 'high': h, 'low': l, 'close': c}
                self.data = pd.DataFrame(data=d)
```

```
In [6]: import dateutil.parser
```

```
In [7]: dateutil.parser.parse('2018-04-04 17:30:00')
```

```
Out[7]: datetime.datetime(2018, 4, 4, 17, 30)
```

```
In [8]: start = datetime.utcnow() - timedelta(days=7*2)
        end = datetime.utcnow()
        #start = dateutil.parser.parse('2018-04-04 17:30:00')
        #end = dateutil.parser.parse('2018-04-12 00:30:00')
                                            # Min * 60 Sec
        #plnx = PoloniexDataFrame('USDT_BTC', 5*60, start, end) #  0.45%
        #plnx = PoloniexDataFrame('USDT_BTC', 15*60, start, end) #  -13.02%
        plnx = PoloniexDataFrame('USDT_BTC', 30*60, start, end) # 23.65%
        #plnx = PoloniexDataFrame('USDT_BTC', 120*60, start, end) # 3.84%
        #lnx = PoloniexDataFrame('USDT_BTC', 240*60, start, end) # 10.948%
```

```
https://poloniex.com/public?command=returnChartData&currencyPair=USDT_BTC&start=1523924361&end=
```

'2018-04-04 17:30:00' '2018-04-12 00:30:00'

## 1.2 Indicators

Indicators to add:

- EMA
- MACD
- BBands
- RSI

### 1.2.1 Daily returns

```
In [9]: def daily_returns(df): df['daily_returns'] = df['close'] - df['close'].shift(1)
```

### 1.2.2 Stdev

```
In [10]: def std(df, n): df['std{}'.format(n)] = df['close'].rolling(window=n).std()
         std_list = [7]
```

### 1.2.3 Simple Moving Average (SMA)

```
In [11]: def sma(df, n): df['sma{}'.format(n)] = df['close'].rolling(window=n).mean()
         sma_list = range(1, 30)
```

### 1.2.4 Adding all the data & indicators

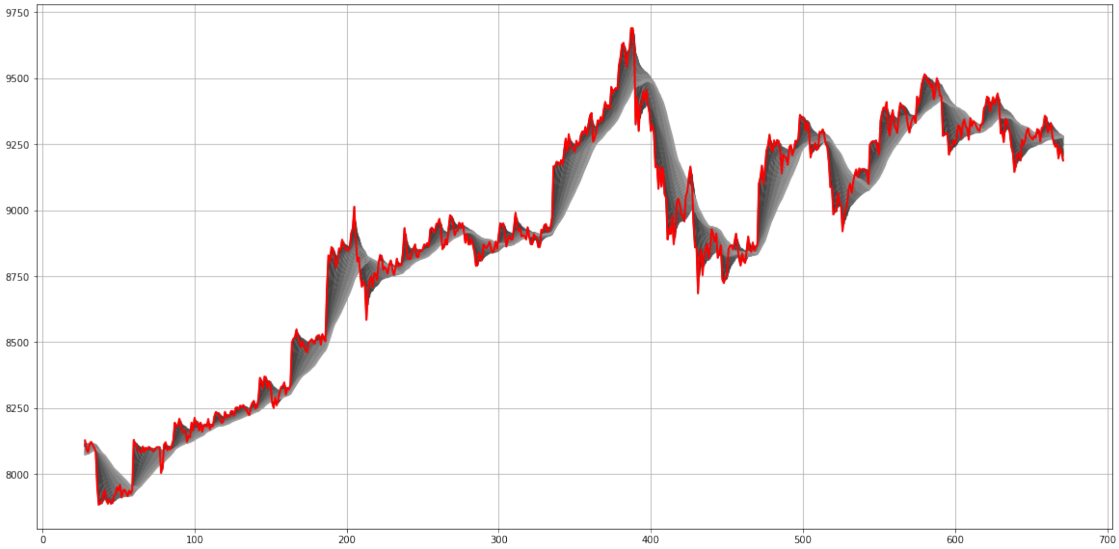
```
In [12]: daily_returns(plnx.data)
         for n in std_list: std(plnx.data, n)
         for n in sma_list: sma(plnx.data, n)
```

```
In [13]: class Indicators():
             std_list = [7]
             sma_list = range(5, 30)
```

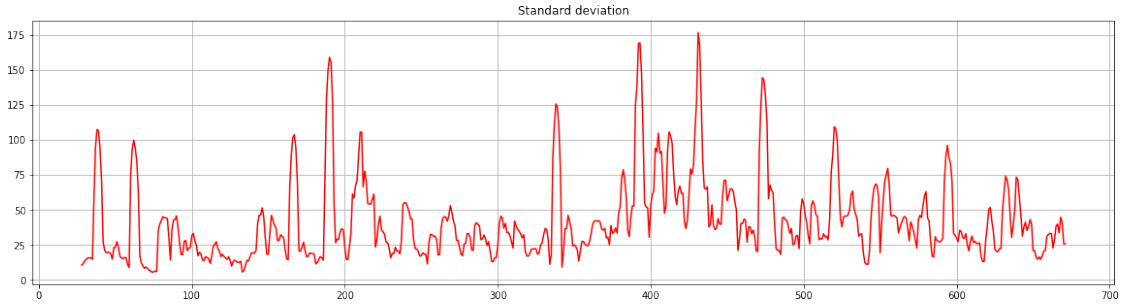
```
    def daily_returns(self, df): df['daily_returns'] = df['close'] - df['close'].shif
    def std(self, df, n): df['std{}'.format(n)] = df['close'].rolling(window=n).std()
    def sma(self, df, n): df['sma{}'.format(n)] = df['close'].rolling(window=n).mean(

    def apply(self, df):
        self.daily_returns(df)
        for n in self.std_list: self.std(df, n)
        for n in self.sma_list: self.sma(df, n)
```

### 1.3 Plot

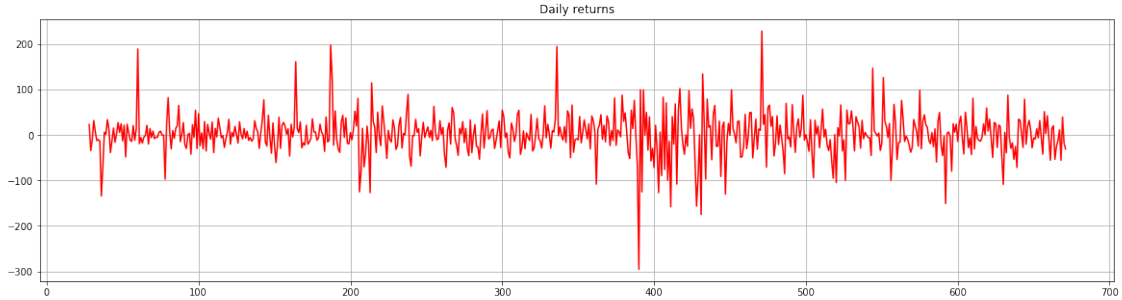
```
In [14]: head=max(sma_list)-1
         plt.figure(figsize=(20,10))

         for i in sma_list: plot(plnx.data[head:]['sma{}'.format(i)], color='#{}'.format(str(3

         plot(plnx.data[head:]['close'], c='r', lw=2)
         plt.grid()
```



```
In [15]: plt.figure(figsize=(20,5))
         plot(plnx.data[head:]['std7'], c='r')
         plt.title('Standard deviation')
         plt.grid()
```



```
In [16]: plt.figure(figsize=(20,5))
         plot(plnx.data[head:]['daily_returns'], c='r')
         plt.title('Daily returns')
         plt.grid()
```



## 1.4 Signals

### 1.4.1 Moving average crossover

```
In [17]: def signals_ma_crossover(df, skip_head, sma_list):
             sma1 = 'sma{}'.format(sma_list[0])
             sma2 = 'sma{}'.format(sma_list[1])
             df['signal_sma_crossover'] = 0
             for i in range(skip_head, len(df)):
                 previous = df.iloc[i-1]
                 current = df.iloc[i]
                 sma_prev = previous[sma1] - previous[sma2]
                 sma_current = current[sma1] - current[sma2]
                 if sma_prev > 0 and sma_current < 0: df.loc[i,'signal_sma_crossover'] = -1
                 if sma_prev < 0 and sma_current > 0: df.loc[i,'signal_sma_crossover'] = 1
```

```
In [18]: signals = signals_ma_crossover(plnx.data, 23, [7, 23])
```

### 1.5 Trading simulation

```
In [19]: class RiskManagement():
             def __init__(self, use_stop_loss, stop_loss_percentage):
                 self.use_stop_loss = use_stop_loss
                 self.stop_loss_percentage = stop_loss_percentage
```

```
In [20]: from matplotlib import gridspec
```

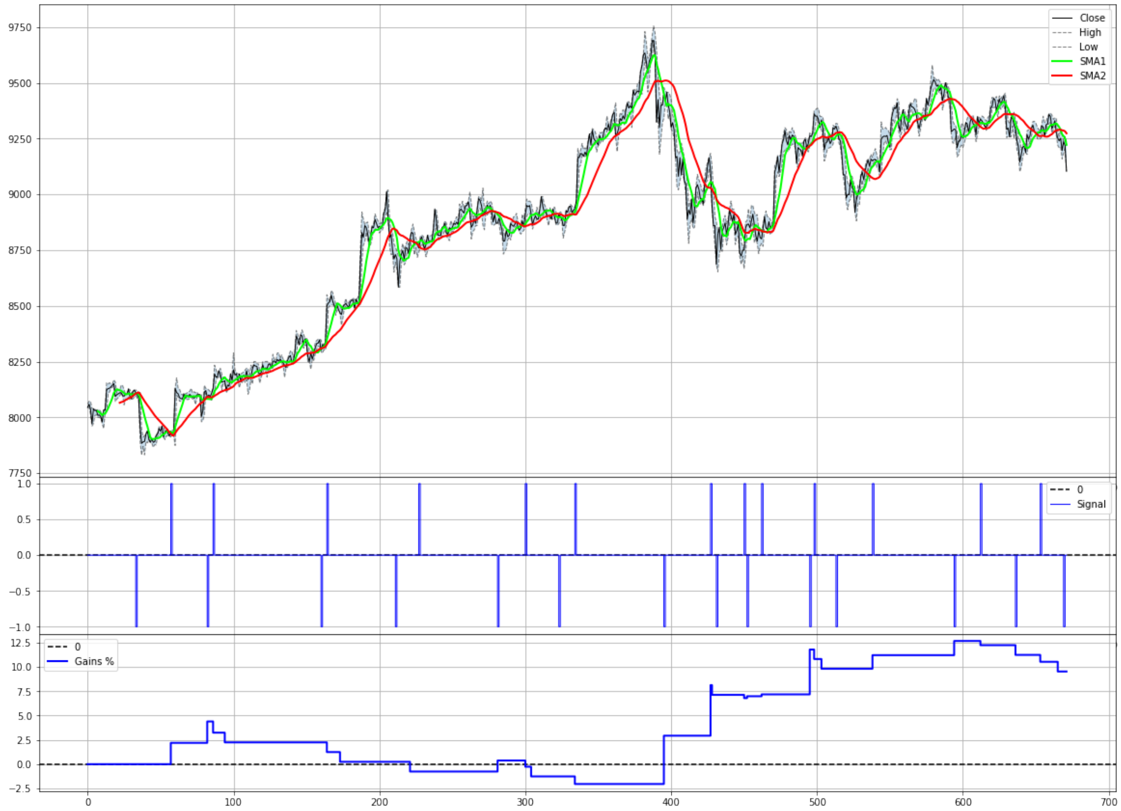
```
In [41]: class TradeSim():
             def __init__(self, df, risk):
                 self.df = df
                 self.risk = risk

             def run(self):
                 state = 'neutral'
                 entry = None
                 entry_timestamp = None
                 tlist = []
                 for index in range(len(self.df)):
                     current = self.df.iloc[index]
                     sma_crossover = self.df.loc[index]
                     if state != 'neutral':
                         pl_low = ((current['low'] / entry if state == 'long' else entry / cur
                         if self.risk.use_stop_loss and pl_low < -self.risk.stop_loss_percentag
                             tlist.append([entry, current['close'], state, entry_timestamp, cu
                             state = 'neutral'
                     if current['signal_sma_crossover'] == 1:
                         if state == 'short':
                             tlist.append([entry, current['close'], 'short', entry_timestamp, c
                             state = 'neutral'
                         entry = current['close']
                         entry_timestamp = current['date']
                         state = 'long'
                     if current['signal_sma_crossover'] == -1:
                         if state == 'long':
                             tlist.append([entry, current['close'], 'long', entry_timestamp, cu
                             state = 'neutral'
                         entry = current['close']
                         entry_timestamp = current['date']
                         state = 'short'
                 self.trades = pd.DataFrame(tlist, columns=['entry', 'exit', 'direction', 'ent
                 self.trades['gains'] = self.trades.apply(self.gains, axis=1)
                 self.trades['gains'] = self.trades.apply(self.stopped_out, axis=1)
                 self.trades['gains_cumsum'] = self.trades['gains'].cumsum()
                 self.add_gains_to_dataframe()

             def gains(self, row):
                 if row['direction'] == 'long':  return (row['exit'] / row['entry'] - 1) * 100
```

```
        if row['direction'] == 'short': return (row['entry'] / row['exit'] - 1) * 100

    def add_gains_to_dataframe(self):
        self.df['gains'] = 0
        for index in range(len(self.trades)):
            t = self.trades.iloc[index]
            self.df.loc[self.df['date'] == t['exit_timestamp'], 'gains'] = t['gains']
        self.df['gains_cumsum'] = self.df['gains'].cumsum()

    def stopped_out(self, row):
        return -self.risk.stop_loss_percentage if row['close_type'] == 'stopped_out' e

    def plot_chart(self):
        plt.figure(figsize=(20,5))
        plot(self.trades['close'])

    def plot_gains(self):
        plt.figure(figsize=(20,5))
        plt.title('Gains (cumulative)')
        plot(self.trades['gains_cumsum'])
        plt.grid()

    def result_statistics(self):
        winners = len(self.trades.loc[self.trades['gains'] > 0])
        losers = len(self.trades.loc[self.trades['gains'] < 0])
        stopped_out = len(self.trades.loc[self.trades['close_type'] == 'stopped_out'])
        print('Period start: {}'.format(self.df.iloc[0]['date']))
        print('Period end: {}'.format(self.df.iloc[len(self.df)-1]['date']))
        print('Total trades: {}'.format(winners+losers))
        print('Winners: {}'.format(winners))
        print('Losers: {}'.format(losers))
        print('Win Ratio: {:.3f}%'.format(winners / (winners+losers) * 100))
        print('Stopped out: {}'.format(stopped_out))
        print('P/L: {:.2f}%'.format(self.df.iloc[len(self.df)-1]['gains_cumsum']))

    def plot_gains_timescale(self):
        gs = gridspec.GridSpec(3, 1, height_ratios=[3,1,1])
        f = plt.figure(figsize=(20,15)) #plt.subplots(gs, sharex=True, figsize=(20,10
        ax1 = plt.subplot(gs[0])
        ax2 = plt.subplot(gs[1])
        ax3 = plt.subplot(gs[2])
        ax1.plot(trade_sim.df['close'], c='black', lw=1.)
        ax1.plot(trade_sim.df['high'], c='black', ls='dashed', lw=1., alpha=0.5)
        ax1.plot(trade_sim.df['low'], c='black', ls='dashed', lw=1., alpha=0.5)
        ax1.fill_between(list(trade_sim.df.index), trade_sim.df['low'], trade_sim.df[
        ax1.plot(trade_sim.df['sma8'], c='lime', lw=2.)
        ax1.plot(trade_sim.df['sma23'], c='red', lw=2.)
        ax1.legend(['Close', 'High', 'Low', 'SMA1', 'SMA2'])
```

```
                ax1.grid()
                ax2.axhline(y=0, c='black', ls='dashed')
                ax2.step(list(trade_sim.df.index), trade_sim.df['signal_sma_crossover'], c='bl
                ax2.legend(['0', 'Signal'])
                ax2.grid()
                ax3.axhline(y=0, c='black', ls='dashed')
                ax3.step(list(trade_sim.df.index), trade_sim.df['gains_cumsum'], c='blue', lw=
                ax3.grid()
                ax3.legend(['0', 'Gains %'])
                f.subplots_adjust(hspace=0)
```

```
In [42]: risk_mgmnt = RiskManagement(True, 1)
         trade_sim = TradeSim(plnx.data, risk_mgmnt)
         trade_sim.run()
         trade_sim.result_statistics()
         trade_sim.plot_gains_timescale()
```

```
Period start: 2018-04-17 02:30:00
Period end: 2018-05-01 02:00:00
Total trades: 26
Winners: 10
Losers: 16
Win Ratio: 38.462%
Stopped out: 9
P/L: 9.54%
```



```
In [36]: trade_sim.trades
```

```
Out[36]:            entry          exit direction       entry_timestamp  \
         0   8100.000000  7926.000000     short 2018-04-17 19:30:00
         1   7926.000000  8100.318522      long 2018-04-18 07:30:00
         2   8100.318522  8194.623789     short 2018-04-18 20:00:00
         3   8194.623789  8122.068420      long 2018-04-18 22:00:00
         4   8325.032183  8513.000000     short 2018-04-20 11:00:00
         5   8513.000000  8461.000000      long 2018-04-20 13:00:00
         6   8710.966633  8830.000000     short 2018-04-21 12:30:00
         7   8793.200000  8892.897111      long 2018-04-21 20:30:00
         8   8892.897111  8950.010000     short 2018-04-22 23:30:00
         9   8950.010000  8862.000001      long 2018-04-23 09:00:00
         10  8901.000000  8971.000000     short 2018-04-23 20:30:00
         11  8971.000000  9416.978028      long 2018-04-24 02:00:00
         12  9416.978028  8951.022350     short 2018-04-25 08:30:00
         13  8951.022350  8859.114000      long 2018-04-26 00:30:00
         14  8820.024272  8850.000000     short 2018-04-26 02:30:00
         15  8850.000000  8867.080000      long 2018-04-26 12:00:00
         16  8867.080000  8850.068461     short 2018-04-26 13:00:00
         17  8850.068461  9258.672572      long 2018-04-26 18:00:00
         18  9258.672572  9350.000000     short 2018-04-27 10:30:00
```

```
19  9350.000000  9294.000000      long  2018-04-27 12:00:00
20  9284.000000  9156.024272     short  2018-04-27 19:30:00
21  9156.024272  9289.610989      long  2018-04-28 08:00:00
22  9289.610989  9330.000000     short  2018-04-29 12:00:00
23  9330.000000  9241.000000      long  2018-04-29 21:00:00
24  9241.000000  9307.000000     short  2018-04-30 09:00:00
25  9307.000000  9240.000000      long  2018-04-30 17:30:00

         exit_timestamp   close_type     gains  gains_cumsum
0   2018-04-18 07:30:00       closed  2.195307      2.195307
1   2018-04-18 20:00:00       closed  2.199325      4.394632
2   2018-04-18 22:00:00       closed -1.150819      3.243813
3   2018-04-19 02:00:00  stopped_out -1.000000      2.243813
4   2018-04-20 13:00:00  stopped_out -1.000000      1.243813
5   2018-04-20 17:30:00  stopped_out -1.000000      0.243813
6   2018-04-21 17:30:00  stopped_out -1.000000     -0.756187
7   2018-04-22 23:30:00       closed  1.133798      0.377611
8   2018-04-23 09:00:00       closed -0.638132     -0.260521
9   2018-04-23 11:00:00  stopped_out -1.000000     -1.260521
10  2018-04-24 02:00:00       closed -0.780292     -2.040813
11  2018-04-25 08:30:00       closed  4.971330      2.930517
12  2018-04-26 00:30:00       closed  5.205614      8.136131
13  2018-04-26 01:00:00  stopped_out -1.000000      7.136131
14  2018-04-26 12:00:00       closed -0.338709      6.797422
15  2018-04-26 13:00:00       closed  0.192994      6.990417
16  2018-04-26 18:00:00       closed  0.192219      7.182636
17  2018-04-27 10:30:00       closed  4.616960     11.799596
18  2018-04-27 12:00:00       closed -0.976764     10.822832
19  2018-04-27 14:30:00  stopped_out -1.000000      9.822832
20  2018-04-28 08:00:00       closed  1.397722     11.220553
21  2018-04-29 12:00:00       closed  1.459004     12.679557
22  2018-04-29 21:00:00       closed -0.432894     12.246663
23  2018-04-30 09:00:00  stopped_out -1.000000     11.246663
24  2018-04-30 17:30:00       closed -0.709144     10.537519
25  2018-04-30 23:30:00  stopped_out -1.000000      9.537519
```

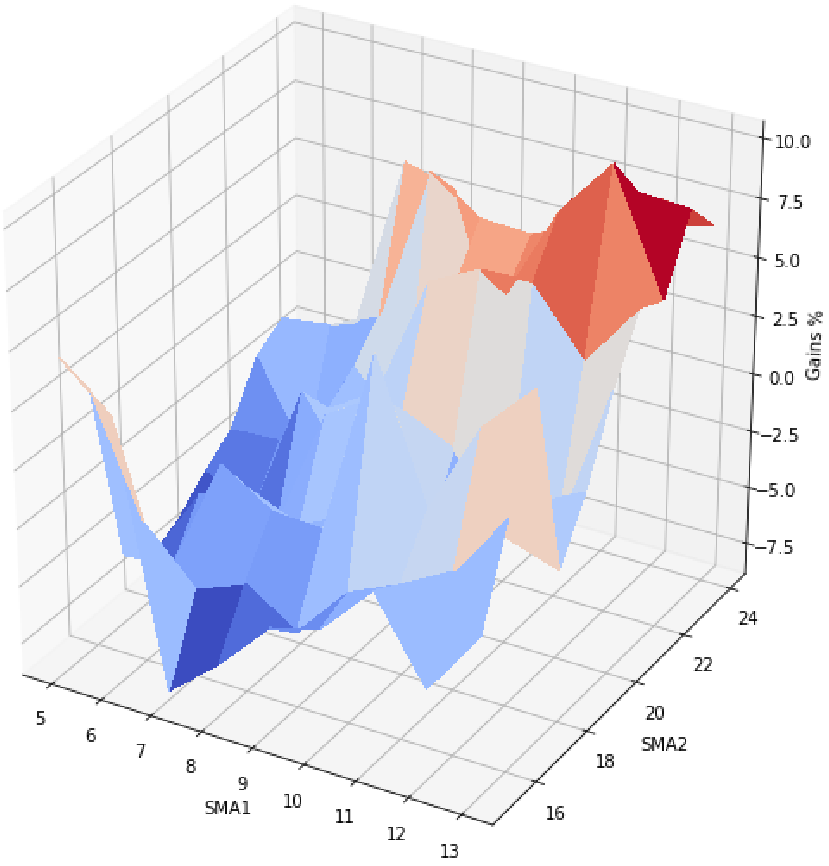
```
In [24]: mask = (trade_sim.trades['gains'] > -1) & (trade_sim.trades["gains"] < 0.075)
         len(trade_sim.trades.loc[mask])
```

```
Out[24]: 8
```

### 1.6 Finding optimal SMA settings

The following code generates a surface plot for two SMA intervals. It may take a while tho.

def get_gains_for_sma(df, a, b): print(‘Calculting gains % for a: {} and b: {}…’.format(a, b)) dfc = pd.DataFrame(df) indicators = Indicators() indicators.apply(dfc) signals_ma_crossover(plnx.data, max(sma_list), [a, b]) risk_mgmnt = RiskManagement(True, 1) trade_sim = TradeSim(dfc, risk_mgmnt) trade_sim.run() return trade_sim.df.loc[len(trade_sim.df)-1][‘gains_cumsum’]



plot

from mpl_toolkits.mplot3d import Axes3D

start = datetime.utcnow() - timedelta(days=72*) end = datetime.utcnow() timeframe = 30*60 plnx = PoloniexDataFrame('USDT_BTC', timeframe, start, end)

sma1 = range(5,14) sma2 = range(15,25)

#sma1 = range(5,7) #sma2 = range(15,17)

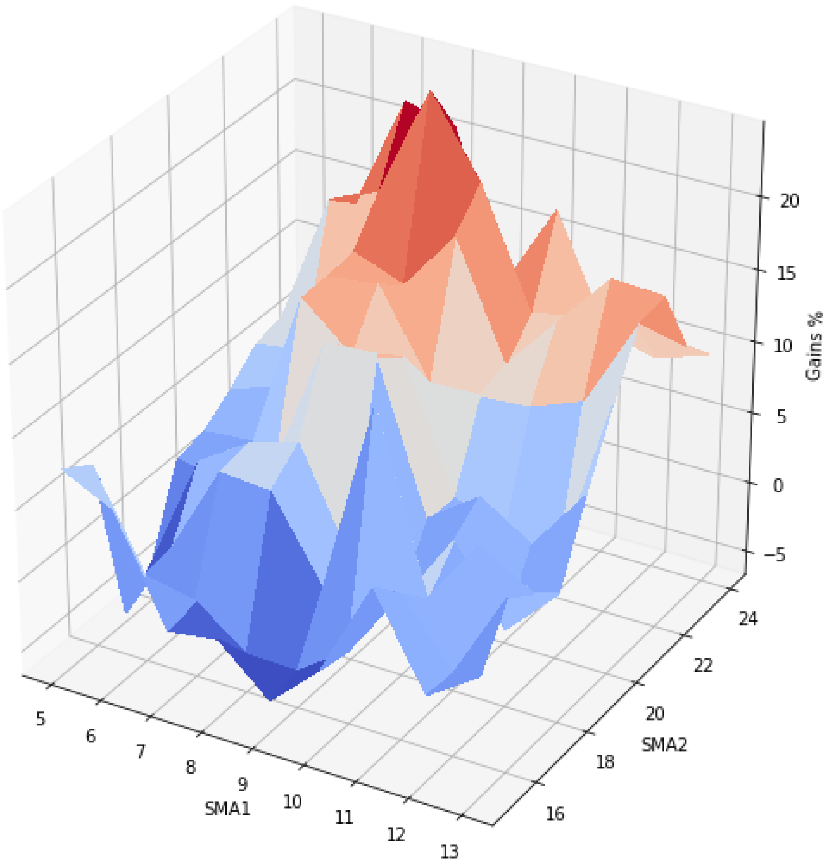
#for x in sma1: # for y in sma2: # print('({}, {}) gains {}'.format(x, y, get_gains_for_sma(plnx.data, x, y)))

limit = 10 X, Y = (np.array(sma1), np.array(sma2)) X, Y = np.meshgrid(X, Y) zs = np.array([get_gains_for_sma(plnx.data, x, y) if x!=y else 0 for x,y in zip(np.ravel(X), np.ravel(Y))]) Z = zs.reshape(X.shape)

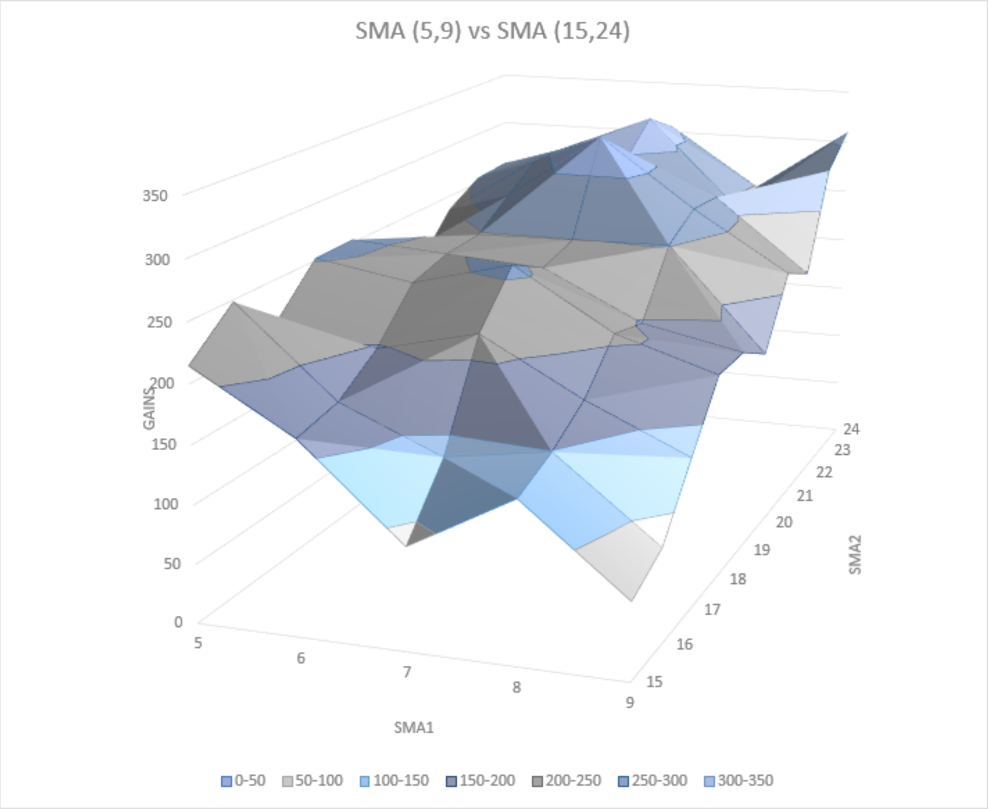
fig = plt.figure(figsize=(10,10)) ax = fig.gca(projection='3d') surv = ax.plot_surface(X,Y,Z, cmap=cm.coolwarm, linewidth=0, antialiased=False) ax.set_xlabel('SMA1') ax.set_ylabel('SMA2') ax.set_zlabel('Gains %')

The following plot shows results for the SMA strategy for SMA1 $[5, 13]$ and SMA2 $[16, 24]$. The timeframe is 30 minutes and the period length is one week.

The following plot shows results for the SMA strategy for SMA1 $[5, 13]$ and SMA2 $[16, 24]$. The timeframe is 30 minutes and the period length is two weeks.



plot2



sma

The following plot shows results for the SMA strategy for SMA1 $[5, 9]$ and SMA2 $[15, 24]$. The timeframe is 30 minutes and the period length is one year.

The settings 7 and 21/23 clearly are the best here.